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PAPERS ON CEREAL AND FORAGE INSECTS.

THE LESSER CLOVER-LEAF WEEVIL.

BY

F. M. WEBSTER, M. S.,
In Charge of Cereal and Forage Insect Investigations.

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PAPERS ON CEREAL AND FORAGE INSECTS.

THE LESSER CLOVER-LEAF WEEVIL.

(*Phytonomus nigrirostris* Fab.)

By F. M. Webster,
In Charge of Cereal and Forage Insect Investigations.

INTRODUCTION.

The lesser clover-leaf weevil is one of the common, generally diffused insects of Europe, being found from Scandinavia southward into Egypt and Asia Minor, although the voluminous classical reports of Miss Ormerod give no intimation of its presence in the British Islands.

The technical literature of the species runs back into the latter part of the eighteenth century. Judging from accounts by the more recent European writers, its habits and development in the Old World do not differ materially from those as observed in America.

Mathieu [a] says: "It is common, and spread all over the fields and plains, especially on the trefoils."

Thomson [b] says that it is "not rare on high meadows all over Sweden."

Capiomont [c] informs us that "it is spread over the north and middle of Europe; also in Algeria, in Egypt, and Anatolie in Asia Minor. It lives on different species of Ononis, and especially on *Ononis spinosa.* The cocoon that the larva makes on the leaves of these plants is altogether similar in texture to that of *Hypera tessellata,* but it is a little smaller and more ovoid."

Kaltenbach [d] says with reference to this species that it "was found by F. Hoffman on *Buphthalmum salicifolium,* in the flower heads of which the larvæ live. The transformation takes place in a cocoon built from chaff leaves [p. 332].

"The larvæ live in the florets of the flowerhead of *Trifolium pratense,* wherein I have repeatedly taken the beetles [p. 124]."

Piero Bargagli [e] states that "in the vicinity of Florence it winters among the moss and under the bark of the alder in the perfect state;

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[a] Annales de la Société Entomologique de Belge. Catalogue des Coleoptères de la Famille des Curculionidées de Belgique, p. 189, 1858.

[b] Skandinaviens Coleoptera, p. 173, 1865.

[c] Annales de la Société Entomologique de France, vol. 8, p. 227,1868.

[d] Pflanzenfeinde aus der Klasse der Insekten, pp. 124, 332, 1874.

[e] Rassegna Biologica di Rincofori Europei, p. 95, 1883–84.

in this stage, and also as larvæ and pupæ, it probably lives on *Trifolium agrarium*. The individuals that have recently passed from the pupal to the perfect state are of a clear brown color and soon take on a green color with warmth [on drying].

"Larva and pupa.—It makes a little cocoon on the leaves of *Ononis spinosa* exactly similar in texture to that of *H. tessellata*, but smaller by half and perfectly ovoid."

HISTORY OF THE LESSER CLOVER-LEAF WEEVIL IN AMERICA.

Just when the species was introduced into America it is now impossible to state. Messrs. Hubbard and Schwarz collected it in eastern Massachusetts during the winter of 1873–74, and Mr. Blanchard, one of the oldest and most careful collectors of New England Coleoptera, is of the opinion that it might have occurred there as early at least as 1865. In connection with this information it must be remembered that up to the time of the publication by Le Conte and Horn of their "Rhynchophora of America North of Mexico," in 1876, our information on this group of insects was very obscure. Besides this, we do not know how long the species had been known by Provancher prior to his description of the species in 1877. As it first became injurious in New Brunswick and elsewhere in extreme eastern Canada, there are fairly good reasons for the assumption that it first gained a foothold in that part of the country, from which it spread by natural diffusion into New York and New England, and while Mr. Blanchard has cautioned me against placing too much stress on his opinion as above expressed, it seems to me that it is of sufficient value to be placed on record in this connection. As a matter of fact, the species in all probability occurred in limited numbers in the sections of the country above mentioned long before its discovery there by entomologists, precisely as was the case with the allied species *Phytonomus punctatus* in New York.

It was not, however, included in any of the earlier lists of the Coleoptera of America north of Mexico, appearing first in Austin's supplement published in 1880. Prior to this, however, in 1876, it had been included by Le Conte and Horn in their "Rhynchophora of America North of Mexico," its distribution being there given as "Massachusetts and Canada." A year later, Abbé Provancher described it in his "Petite Faune Entomologique du Canada" under the name *Erirhinus viridis*.

In 1884[a] Dr. James Fletcher stated that during the month of July he had found a small Phytonomus committing great damage in the clover at Dalhousie, New Brunswick. He had taken it for *P. nigrirostris* at first, but fancied it might be a different species, as nearly all the specimens reared were light cinnamon brown in color. (These specimens have since been identified as *Phytonomus nigrirostris.*) In the same year (1884) Mr. W. H. Harrington stated that *Phytonomus nigrirostris* occurred in considerable numbers in the vicinity of Ottawa, but that he had not found any evidences of the destructive habits described by Mr. Fletcher. He added, however, that it was known to attack clover in Europe.

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[a] See bibliography, p. 10.

In 1885 Dr. C. V. Riley stated that it had been observed by Dr. James Fletcher to attack clover in Canada. In 1899 Doctor Fletcher himself stated that in Canada it was a more general and destructive pest to clover than its congener, *P. punctatus.* In another place Doctor Fletcher stated that a considerable quantity of red and mammoth clover was injured about Ottawa by the insect just before the blooming season in June. During the same year Dr. C. H. Fernald stated that the smaller clover-leaf beetle, *P. nigrirostris,* was very common on the Massachusetts Agricultural College farm at Amherst, Mass., and quite destructive to the clover growing thereon.

In 1890 Doctor Fletcher stated that he had frequently found the larvæ feeding on the heads of clover, and that he had observed the insect in many parts of Canada.

In 1895 Mr. W. H. Harrington reported it as more numerous than any other of the 9 species of Curculionidæ hibernating in moss about the margins of swamps, November 17 to 23. Of the other 8 species there were, all told, 10 individuals and 35 of *P. nigrirostris.*

Mr. E. A. Schwarz (1908) states that *P. nigrirostris* is either a circumpolar species or else has been introduced into the Northern States long ago; for, as far back as the records go, it has always been quite common, ranging from New England westward to Michigan and Minnesota. Some years ago it had been found by him at Fortress Monroe, Va., and recently Messrs. I. J. Condit and J. H. Beattie, of the Bureau of Entomology, had found it at Arundel, Md., while others had found it near Washington, D. C., and on Plummers Island, in the Potomac River above Washington. Insects introduced into the Boreal Zone have not, in his opinion, the power of spreading southward, as can be exemplified by a large number of species. In this instance it seemed that there was another and distinct importation at some harbor south of New York.

Mr. C. O. Houghton (1908) gave the results obtained from a careful rearing of the insect in confinement, as well as some additional data relative to the time of appearance in spring. Although he labored under the disadvantage of rearing the insect under artificial conditions with clover leaves inclosed in vials and hence was unable to secure exact field results, yet his was the first published study of the development of the insect in this country. Further references to his paper will be made in the proper places.

Mr. R. L. Webster (1909) called attention to the seemingly maritime preferences of the beetle, noting its occurrence in New Brunswick (Fletcher) and at Nantucket, Mass., where it was taken by the late Mr. Bolter, specimens being in the Bolter collection at the University of Illinois. The fact here brought out is that, although long ago found by Schwarz in Michigan and reported by him from Minnesota, it has never been abundant inland, and is still injurious only throughout the northern and central Atlantic coast region.[a]

TREND AND METHODS OF DISPERSION.

It seems probable that this species was introduced into either Canada or New England early in the last half of the last century. If, as is entirely possible, it gained its first foothold in America about Quebec or Montreal, Canada, it probably followed the same general trend of diffusion as other insects that were first introduced into that section, and spread southward into New England and New York, thence westward and either along the south shore of Lake Erie or across lower Ontario into the lower peninsula of Michigan, where Mr. Schwarz collected it about Detroit in 1875.

With reference to its diffusion southward there is considerable obscurity. As stated by Mr. Schwarz, page 3, insects introduced into the Boreal Zone do not spread southward in the same manner that they do to the westward, and in this the gentleman is in all probability correct. But the fact that this and other introduced species are being discovered along the coast as far south as the mouth of the Chesapeake Bay indicates that there may be some obscure force at work with which entomologists are not yet familiar. The fact that such species do not diffuse themselves over the country to the southward in a manner that can be followed as clearly as to the westward does not preclude the possibility of their occupying this southern country without separate and distinct introductions.

The current of the Gulf Stream, it is well known, is more or less parallel with, but at a greater or less distance from, the shore, and, while the direction is more or less northeasterly, there is a countercurrent that runs close inshore and in precisely the opposite direction. If one will stand upon the seashore and note the direction from which the débris comes that is thrown upon the beach he will notice that the trend is southward and that débris of this nature that is thrown on the beach at low tide is caught up as the tide comes in and is lodged still farther to the southward.

It does not seem impossible, therefore, that these insects may be carried into the sea by streams, or perhaps by winds blowing offshore at points along the New England and New Jersey coasts, carried southward, drifted with the tide into the mouth of the Chesapeake Bay, and left with the driftwood and other rubbish where they can easily make their way to higher lands where their food plants occur in greater or less abundance.

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[a] According to some notes given me by Dr. F. H. Chittenden, the species was not found about Ithaca, N. Y., up to 1884, but was noted there in abundance in 1904. Also he had noted it abundantly about South Woodstock, Conn., in 1888, and along the seashore on Coney Island in 1891.

No one has actually followed out this possible means of dispersion, but in accounting for the occurrence of transatlantic species which are known to have been introduced into either extreme eastern Canada or New England, and in a number of cases found about Norfolk and Fortress Monroe, it seems possible that some element of this nature is at work. It would be a profitable investigation for anyone who was conveniently situated to take measures to determine whether or not these introduced species may in this manner be carried southward and lodged along the coast.

INVESTIGATIONS CARRIED ON IN THE DISTRICT OF COLUMBIA AND VICINITY.

As has just been shown, the species has been known for some time both to the north and south of the District of Columbia, but only within a couple of years has it become at all common in the immediate vicinity of Washington. The information here given was obtained through the combined efforts of several field assistants, during brief temporary periods passed here in Washington, and well illustrates what may be accomplished by a free and hearty cooperation among individuals composing a limited body of investigators, even when working under very serious disadvantages.

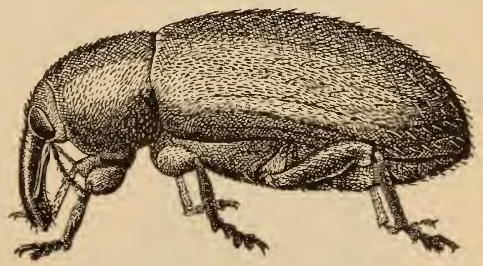

FIG. 1.—The lesser clover-leaf weevil (*Phytonomus nigrirostris*): Adult, much enlarged. (Original.)

No credit whatever is to be accorded the author, beyond the direction of these investigations and a compilation of the results obtained.

The first note to be made on the species, here in the District of Columbia, was by Mr. Paul Hayhurst, who found, June 27, 1907, a single adult (fig. 1) on a leaf of red clover, *Trifolium pratense*, close by a freshly eaten hole in the leaf. The locality where it was found, Grant road, lies just north of the city and within the District.

Next, and nearly a year later, Mr. C. N. Ainslie, while awaiting a train connection at Weverton, about 50 miles northwest of Washington, in Maryland, found the blooming heads of clover infested as described below, but of course did not recognize the species until the adult was reared. The notes on this collection of larvæ are as follows:

"A handful of red clover heads infested with larvæ was gathered, May 20, 1908, beside the Baltimore and Ohio Railroad station during a train wait. These larvæ (fig. 2) were eating in the bases of the florets, beneath the surface of the head (fig. 3, *b*), and moved rapidly out of sight when disturbed. About 25 per cent of the heads examined were infested. Observed but one larva in each head. Some twenty or twenty-five heads were brought to Washington to rear the larvæ.

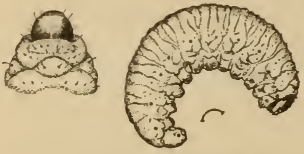

FIG. 2.—The lesser clover-leaf weevil (*Phytonomus nigrirostris*): Larva, much enlarged. Natural length indicated by line under figure. Head and cervical shield, greatly enlarged, at left. (Original.)

"May 25. The larvæ have left the heads and spun coarse-meshed cocoons under the muslin that covers the jar in which they had been placed (fig. 4).

"On June 1 five adult beetles were found emerged from this material, and a sixth was nearly ready to leave the cocoon. The cocoons from which the five emerged have entirely disappeared."

On June 6 Mr. Ainslie, together with Mr. A. N. Caudell, found red clover heads, gathered from beside the electric-car line near Chevy Chase circle, north of Washington, at the District line, infested with larvæ and cocoons of *Phytonomus*. The beetle was quite common, perhaps 20 per cent of the heads being infested by larvæ. The cocoons (see fig. 4) were generally spun among the now nearly full-blooming heads (fig. 3, *a*), although one was found on a clover leaf by Mr. Caudell. One adult of a green color was taken, those that had previously been reared being brown with green lines on the thorax.

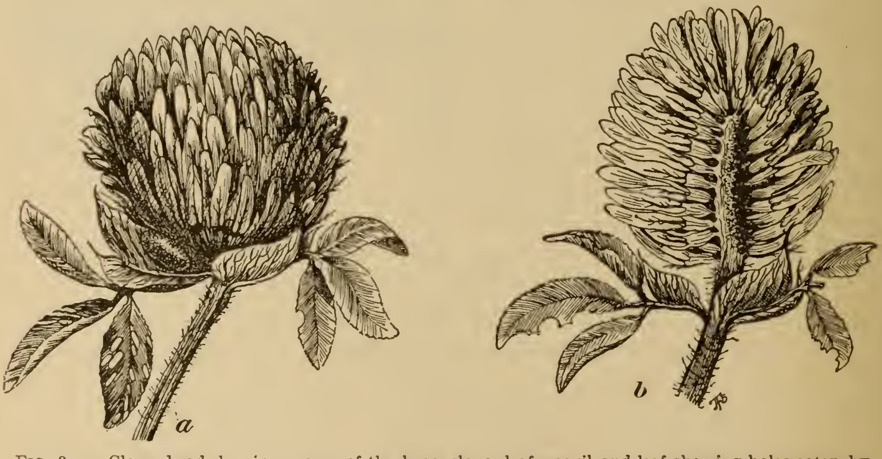

FIG. 3.—*a*, Clover head showing cocoon of the lesser clover-leaf weevil and leaf showing holes eaten by the larvæ; *b*, clover head attacked by the lesser clover-leaf weevil (*Phytonomus nigrirostris*) and leaf eaten by the clover-leaf weevil (*P. punctatus*). (Original.)

It now became necessary for Mr. Ainslie to leave for an indefinite period and Mr. Caudell took temporary charge of the investigation.

On June 12 he again visited the locality and made further search for this insect in heads of red clover, commencing first near Grant road, before mentioned, and working northward along the electric line toward Chevy Chase. Not a single clover head was found to be infested until the exact point where he and Mr. Ainslie had found the infested clover heads on June 6. The plants had been mown several days previous to Mr. Caudell's visit, but among a few heads that had escaped the mower at this particular point two were found to be infested. In the case of one, the adult had issued, and in the other it was still in the pupa (fig. 5), although it issued on the following morning. A further search was made to the westward, about the golf grounds, where occasional plants were growing, and four or five infested heads were found, but they were by no means as abundant as at the previously mentioned point near Chevy Chase circle. This would indicate a possibility of an excessive abundance in one particular locality, while occurring rarely or not at all elsewhere in the immediate vicinity.

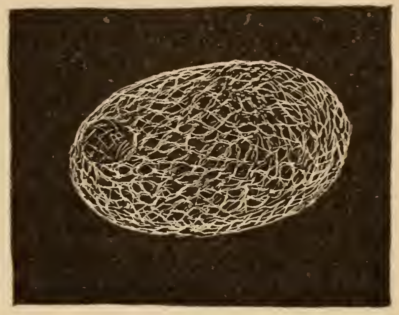

FIG. 4.—The lesser clover-leaf weevil: Cocoon. Much enlarged. (Original.)

From the material collected June 12 there appeared three adults on the 18th. These were found to be of a brown color, while those observed in the fields were all of a greenish hue.

On June 17 Mr. Caudell brought in from the fields a single larva and placed it in a breeding jar. On the 20th it spun a cocoon on the inside of the jar, pupated on the night of the 22d, transformed to the adult on the 25th, eating its cocoon, and finally emerged on the 26th, thus giving six days from the construction of the cocoon to the emerging of the adult. At this time Mr. Caudell was relieved by Mr. J. A. Hyslop, who watched the change of color in the adults from brown to green.

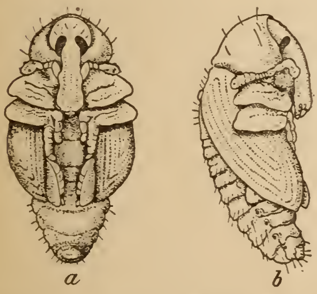

FIG. 5.—The lesser clover-leaf weevil. Pupa: *a*, Ventral view; *b*, lateral view. Enlarged. (Original.)

Of the three adults emerging on June 18, Mr. Hyslop found that on the 24th two had become of the normal greenish hue and the third was in a transitional state, the green appearing on the anterior half of the elytra. The individual that emerged on June 26 reached the full normal greenish color on July 7.

While all of this information is new to American literature, it will be noted that Hoffman long ago found the larvæ feeding in clover heads in Europe. (See Kaltenbach, loc. cit.) There seems, however, to be a difference in the time required for the change in color, as between European and American adults, as Bargagli (loc. cit.) states that this change takes place "soon," on drying.

Invariably the adult devoured its cocoon or as much of it as could be detached from the object to which it was spun. In Mr. Houghton's excellent paper (1908) the change of color in the adult was not recorded and he was unable to account for the consumption of the cocoon by the single adult under his observation, except on the score of a total lack of other food.

We lost track of the adults in July, as Mr. Hyslop was absent from the District, so that no connected observations could be made, but it appears that after developing in the fields the beetles disperse very much as do those of *P. punctatus*, which, during summer, is as likely to be found crawling over the walks and pavements of cities and towns as anywhere else.

On September 23 the author took a single individual, either an undersized female or a male, on the inside of his office window, while Mr. Hyslop found a single individual at the roots of a wheat plant in the middle of a wheat field at Marion, Pa., November 21, 1908. This concluded the first year's observations on the species.

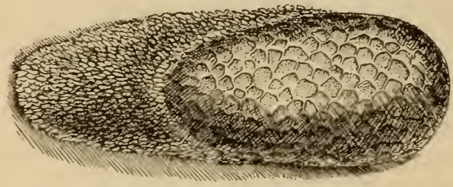

FIG. 6.—Egg of the lesser clover-leaf weevil placed interepidermally in leaf, with part of egg surface exposed, showing granulation. Highly magnified. (Original.)

Mr. Houghton states in his paper that the earliest date on which he found adults in spring in Delaware was April 12. Mr. Hyslop found adults in the same locality as that visited in 1908, among the dead and dried leaves and stems of the previous year's growth, on April 1, when the sexes were pairing preparatory to oviposition. Adults taken at this time, however, did not deposit eggs for a week, so it would seem that they were only just commencing their activity. He had not searched for them earlier, the season being somewhat backward, and it is probable that they may be found about the clover plants as soon as the weather becomes warm enough to start the growth of the young leaves. Female beetles confined in small vials with clover leaves deposit eggs somewhat as described by Mr. Houghton, as follows:

"Several were found situated interepidermally, sometimes singly, sometimes in pairs. They were inserted through punctures, sometimes made through the upper epidermis of the leaf, sometimes through the lower, apparently. * * * The unusual way in which part of the eggs were laid in this case was that a bunch of six, somewhat irregularly stuck together, was deposited upon one of the leaves."

Mr. Hyslop found that the female, when confined on a leaf, frequently placed her eggs interepidermally in the cavity between the upper and lower epidermis along the sides of the midrib, inserting them through an opening made on the upper surface of the leaf, and in groups of from one to four. About this time Mr. Hyslop was expecting daily to start for the Pacific coast, and both he and Mr. V. L. Wildermuth carried on the investigation for a short time together, but neither was able to find eggs deposited in or on the surface of the leaves, in the fields, although they did find them pushed transversely under the epidermis of the base of the leaf sheaths (see fig. 7). When the female was confined on a single leaf, eggs were often found in groups, placed with no reference to the midvein, and in such cases there was a deceptive resemblance to a matrix of adhesive mucilaginous matter with the eggs placed on instead of in the leaf. Mr. Wildermuth, however, discovered that this illusion was due to the fact that the incision in the leaf was made in the upper surface, through the substance to the lower epidermis, so that when the eggs were pushed into the sac thus formed they lay between the leaf-substance on one side and the epidermis on the other, and were thus forced against this elastic and nearly transparent lower epidermis, which, while remaining intact, became so adjusted about the group of eggs as to give them the appearance of having been placed on the surface and in a matrix which hardened and adhered to both eggs and leaf surface. Figure 6 shows an egg greatly enlarged, with the epidermal covering removed, showing the granulation of the eggshell. Mr. Wildermuth, late in April, examined hundreds of leaves without finding a single egg on the leaf itself, while there was no difficulty whatever experienced in finding them, more often in threes, placed under the epidermis of the basal leaf sheaths as shown in figure 7. So uniformly was this the case

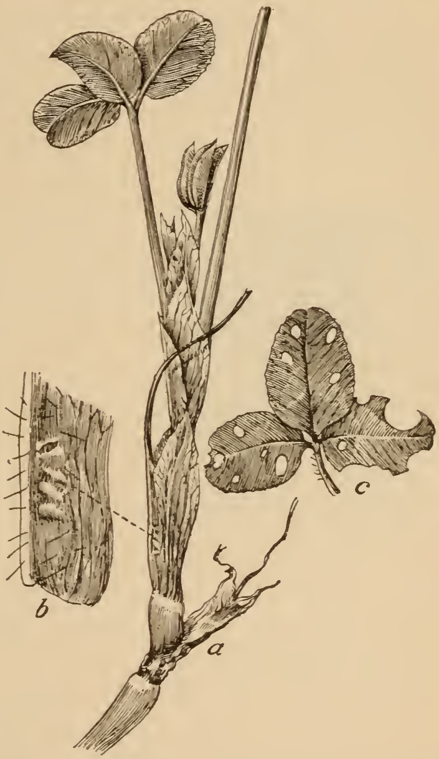

Fig. 7.—*a*, Clover plant showing place of oviposition of the lesser clover-leaf weevil; *b*, section of same, greatly enlarged; *c*, leaf showing holes made by larvæ of the lesser clover-leaf weevil (*Phytonomus nigrirostris*) and edges eaten out by the clover-leaf weevil (*P. punctatus*). (Original.)

that there seemed no other alternative than to concede this to be the normal mode of oviposition. Eggs removed from the basal leaf sheaths are illustrated, greatly enlarged, in figure 8. While they are somewhat obscure when freshly deposited, they change to a dark color in a few days, and, though minute, are then easily distinguishable.

SEASONAL HISTORY.

In the vicinity of Washington, D. C., the adults come forth from their hibernation in the fields as soon as the warm weather starts the young growth of the clover, probably during the last of March in ordinary seasons. The sexes pair, and egg deposition soon commences. Females brought from the fields near Washington, on April 1, during the somewhat cold and backward spring of 1909, deposited eggs indoors on April 6. In the fields the first eggs were probably overlooked because it was not known on just what part of the plant it was necessary to search for them. As observed by Mr. Wildermuth, the egg period varied from seven days twenty hours to eight days twelve hours.

The larval period varies from seventeen to twenty days, the former being probably near the normal. The larva molts twice, the first instar occupying from three to seven days, the second from six to seven days, and the third about seven days.

The pupal stage occupies, normally, about six days, and the entire period from egg to adult about thirty-two days. Of course temperature will always affect the length of the different periods to some extent.

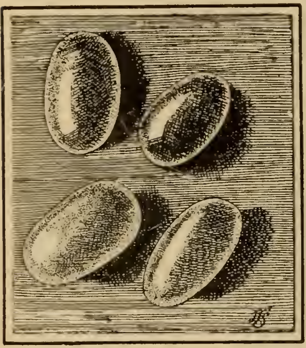

FIG. 8.—The lesser clover-leaf weevil: Eggs. Greatly enlarged. (Original.)

While there is clearly but a single annual generation, the breeding season is greatly prolonged, egg deposition probably covering upward of six weeks, and late in this season all stages may be observed at the same time.

While the larvæ can feed on all parts of the clover plant above ground, they prefer the tenderest unfolding leaves, and in the fields they select these parts and feed among the folds; later, they attack the heads, both young and in full bloom (fig. 3, *b*). While the larvæ of both *Phytonomus punctatus* and of the species under consideration frequently occur on the same plant, the work of the two is quite different and easily separated. This difference is shown in figures 3 and 7, the latter figure illustrating the work of both species in the same leaf.

After emerging, the adults probably scatter abroad over the fields and hibernate among leaves, matted grass, and other rubbish.

DESCRIPTIONS.

The adult (fig. 1).—"Green; snout black. Inhabits England. Herbst. Arch. tab. 24, fig. 3. Head brown; snout cylindrical, black, polished; thorax gibbous, rounded, green, with 2 dorsal brown lines; shells downy, immaculate; legs brown." (Original description.)

The egg (figs. 6, 8).—The egg is ovoid, pale greenish at first, but darker as incubation advances, surface distinctly reticulated. Length, 0.55^{mm} to 0.63^{mm}; width, 0.35^{mm} to 0.36 ^{mm}. (Description by Hyslop and Webster.)

The young larva.—The newly hatched larva is 1.25^{mm} in length and 0.25^{mm} broad. Color white, with pinkish tinge, best seen on ventral surface. Head large, with the cervical shield pale brown, the latter divided by a broad median white line, the inverted V-shaped mark on head also white; body with sparsely placed setæ, longer and more conspicuous on the anal segments. In a short time the pink tinge disappears, the head becomes black, and the inverted V-shape line extends across the now black thoracic shield, and along the entire length of the body it is produced in a very delicate, pale median dorsal line. (Description by Wildermuth and Webster.)

The full-grown larva.—The full-grown larva is of a greenish straw color. Head light brown. The inverted V-shaped white line is still quite visible on the head. The cervical shield has lost its color, but the faint dorsal white line is still noticeable throughout the whole length of the body. The setæ are still prominent, there being four long ones on each segment, those on the last two segments being very long. (Description by Wildermuth and Webster.)

The pupa.—Pupa distinctly resembling the adult. Abdomen almost colorless, with a slight tinge of yellow. Head, thorax, and appendages increasing in density of black from time of pupation until emergence. A very distinct white line passes through center of dorsal surface of thorax and head, and continues on through the beak, where it reaches its greatest width. (Description by Wildermuth.)

NATURAL ENEMIES.

Two parasites have been reared from the larvæ of this species. Among the material brought into the office by Mr. Caudell on June 12, collected about the golf grounds near Chevy Chase, were two cocoons of this species, one of them containing a larva which at the time appeared to be dead. A few days later, however, this larva made its way out of the cocoon, and in crawling toward the mouth of the breeding vial it pushed its way between the end of the cork stopper and the side of the vial, where it transformed to a puparium. On the morning of June 23 from this puparium a small fly emerged, determined by Mr. C. H. T. Townsend as *Anisia* species, near *variabilis* Coq., one of the Tachinidæ. There can be no doubt that it is parasitic on the larva of *P. nigrirostris*.

A larva taken from a clover head beside Grant road, in the District of Columbia, June 26, 1908, developed into an adult hymenopterous parasite that emerged July 8, 1908. It was determined by Mr. J. C. Crawford as *Bracon* sp.

The pupæ are destroyed by a fungus [*Empusa* (*Entomophthora*) *sphærosperma*]. Should the pest ever become excessively abundant it will prove not only a difficult one to manage, but decidedly destruc-

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tive as well. The effect of this fungus will, however, probably be sufficient to hold it in check, as it does its larger relative, *Phytonomus punctatus*.

FOOD PLANTS.

Dr. James Fletcher found this weevil attacking red clover (*Trifolium pratense*) and mammoth clover (*T. medium*) about Ottawa, Canada. Mr. Wildermuth observed the adults feeding on the leaves of alfalfa (*Medicago sativa*), crimson clover (*T. incarnatum*), white clover (*T. repens*), and alsike clover (*T. hybridum*) in the vicinity of Washington, D. C.

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